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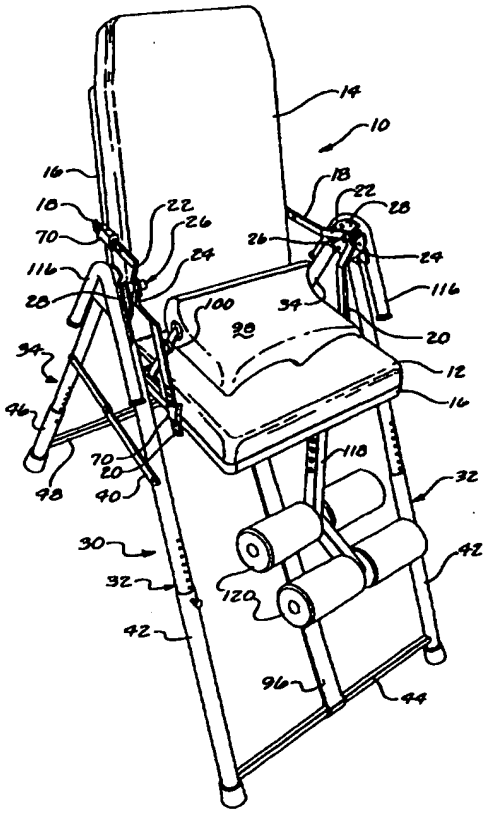
(54) **Title:** INVERSION DEVICE

(57) **Abstract**

Support arms (18, 20; 18', 20'; 18", 20") are coupled between a chair back (14, 14') and seat (12, 12') and trunnions (26, 26', 26") located at opposite sides of the chair (10, 10', 10"). The trunnions (26, 26', 26") are journaled in a stand (30, 30') such that the chair (10, 10', 10") is rotatable about the trunnion axis. A lap restraint (98) engages the upper thighs of a user to secure the user to the seat (12, 12'). The effective lengths of the support arms (18, 20; 18', 20'; 18", 20") (i.e., the distance between the chair back (14, 14') and seat (12, 12') and the trunnions (26, 26', 26")) are adjustable to adjust the center of gravity of the chair (10, 10', 10") and occupant relative to the trunnion axis.



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INVERSION DEVICE

Field of the Invention

The present invention relates to a chair swingably supported on a stand for movement between an upright position (seat approximately horizontal and head above the legs) and an inverted position (seat approximately horizontal, but head below the legs).

Background of the Invention

As described in *Better Back Better Body, The New Inversion Way*, by Joanne Broatch, first published in 1982 by Good 80's Enterprises, Inc. of Vancouver, B.C. Canada, and republished in 1993 by STL International, Inc., of Tacoma, Washington, expressly incorporated by reference herein, traction is a recognized method of treating various types of back ailments. There are three general types of conventional traction: sustained traction where pull is maintained steadily over a period of time; intermittent traction where the pull is maintained for one-half to two minutes at a time, released and then repeated several times; and rhythmic traction where the pull and release are alternated more quickly.

In addition, traction can be "mechanical" or "natural." Mechanical traction involves the use of head (or upper torso) and leg (or lower torso) restraints secured to lines and weights to apply tension to the spine. Natural traction involves hanging and using the weight of the body to provide the tensional force on the spine. Natural traction can be achieved by hanging in an upright position, but an alternative method more pertinent to the present invention is "inverted natural traction" in which the body is supported in a more or less inverted position.

Inverted natural traction can be achieved by use of ankle-attached "inversion boots" having hooks to fit over an elevated horizontal bar such that the body hangs vertically downward from the bar. Achieving the inverted position, and getting off the bar, is difficult for some people; only a single inverted angle is possible; and this method is not conveniently adapted for intermittent or rhythmic traction.

Inversion tables are known in which a user is secured to a swingable table in an upright, inclined or lying position, followed by swinging the table to a more or less inverted position. Inversion tables typically are more expensive than inversion boots, and take up more space.

Another option for inverted natural traction which is more pertinent to the present invention is an inversion chair of the type shown in Seiber U.S. Patent No. 4,214,790. The seat and back of the chair are maintained at a fixed angle relative to each other, and the user is strapped into the chair by a lap belt. The chair is rotatably supported on a base. A belt drive operated by a hand crank or motor can be used to rotate the chair until the user assumes a substantially inverted position.

Summary of the Invention

The present invention provides an inversion device including a chair having a back fixed relative to a seat, and supporting structure for trunnions located above the seat and in front of the back. The trunnions are journaled in a stand such that the chair is rotatable about the trunnion axis. A lap restraint engages the upper thighs of a user to secure the user to the seat.

In a first embodiment, the trunnion support structure includes horizontal arms extending forward from the chair back and vertical arms extending upward from the chair seat. Such arms have adjacent ends joined to the trunnions. The other ends of the arms are coupled to the back and seat in such a way as to permit adjustment of the effective lengths of the arms, which has the effect of adjusting the position of the center of gravity of the swingable unit (chair and occupant) relative to the trunnion axis. Ideally, the center of gravity is positioned at approximately the same height or slightly below the trunnion axis, and slightly in front of the trunnion axis when the user first sits in the chair. A stop prevents forward rotation of the chair while the lap restraint is secured. Thereafter, the user can manipulate his or her body position, such as by leaning back and raising the arms, to shift the center of gravity rearward and upward, which has the effect of inverting the chair. Similarly, the user can swing back to the upright position by changing his or her body position. Handholds are provided on the stand, to be grasped if assistance is required in shifting from one position to the other.

In second and third embodiments, power drive mechanism is provided to change the position of the chair relative to the trunnions, for adjusting the position of the center of gravity of the swingable unit relative to the axis of rotation. From an initial position in which the center of gravity is located slightly forward and below the axis, in which the chair is biased to a forward position against a stop, the chair is shifted rearward by the power drive mechanism. When the center of gravity passes from in front of the swinging axis to behind it, the chair swings rearward to a reclined position. The shifting of the center of gravity relative to the trunnion axis is continued until the chair has reached the desired inverted position. The chair can be returned to the upright position by reversing the shifting of the center of gravity relative to the swinging axis.

Brief Description of the Drawings

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a top front perspective of an inversion device in accordance with the present invention, including a swingable chair and a stand;

FIGURE 2 is a side elevation of the device of FIGURE 1;

FIGURE 3 is an enlarged, top, front perspective of interfitting components of the device of FIGURE 1, namely, a trunnion structure, with parts shown in exploded relationship;

FIGURE 4 is an enlarged top rear perspective of other interfitting components of the chair of FIGURE 1, namely a trunnion support arm and chair mounted bracket, with parts shown in section and parts broken away, and FIGURE 5 is a top plan of the components of FIGURE 4;

FIGURE 6 is a top front perspective of other interfitting components of the chair of FIGURE 1, namely, an infinitely adjustable latch for a lap restraint;

FIGURE 7 is a side elevation corresponding to FIGURE 2 illustrating rearward swinging of the chair, and FIGURE 8 is a side elevation corresponding to FIGURES 2 and 7 with the chair in an inverted position.

FIGURE 9 is a diagrammatic side elevation of a second embodiment of an inversion device in accordance with the present invention, and FIGURES 10-12 are corresponding side elevations of the device of FIGURE 9 but with parts in different positions;

FIGURE 13 is a top front perspective of a third embodiment of an inversion device in accordance with the present invention;

FIGURE 14 is a side elevation of the device of FIGURE 13, and FIGURES 15-17 are side elevations corresponding to FIGURE 14 but with parts in different positions, illustrating inversion of the chair of such device.

Detailed Description of the Preferred Embodiment

The inversion device of the present invention consists of a chair swingably mounted on a stand for rotation between a normal upright position and an inverted position. In the embodiment shown in FIGURES 1 and 2, the chair 10 includes a seat 12 and a back 14. The seat and back are maintained in fixed relationship by an underlying frame 16. As described in more detail below with reference to FIGURES 4 and 5, upper normally horizontal support arms 18 are coupled to the back of the frame at corresponding locations spaced above the seat. Similarly, normally upright support arms 20 are coupled to the bottom of the frame at locations spaced forward of the back. At each side of the chair, the forward end portion 22 (FIGURE 1) of arm 18 is pivotally coupled to the upper end portion 24 of arm 20 by a trunnion 26, described in more detail below with reference to FIGURE 3.

Still referring to FIGURES 1 and 2, trunnions 26 are journaled in upper brackets 28 of a stand 30. One such bracket is provided at each side of the stand, supported spaced above a floor or other surface by front legs 32 and rear legs 34. Each front leg 32 has an upper end portion 36 (FIGURE 2) pivotally secured to bracket 28 and is inclined downward and forward from the pivotal connection. Each rear leg 34 has an upper end portion 38 rigidly secured to bracket 28 and extends downward and rearward therefrom. Foldable braces 40 extend between the central portions of legs 32 and 34 to limit the maximum angles of inclination. In addition, front legs 32 have their bottom end portions 42 connected by a crossbar 44. The bottom end portions 46 of the rear legs 34 are connected by a crossbar 48.

With reference to FIGURE 3, each bracket 28 is in the form of an upright plate having an elongated upward-opening slot 50. The associated trunnion 26 is in the form of a generally cylindrical bushing having a circumferential groove 52 for fitting in the slot. The upper end 24 of support arm 20 and the forward end 22 of support arm 18 have holes 54 that fit over an inward projecting body portion 56 of the trunnion. Such ends of the support arms can be spaced apart by a low friction washer 58. A bolt 60 extends through the axial bore 62 of the trunnion bushing, and a lock nut 64 is screwed onto the inner end portion of the bolt for joining the trunnion to the support arms without clamping the joined ends of the arms together. The lock

nut is tightened against the inner end of the trunnion body portion 56, and such body portion is of a length sufficient that the adjacent ends of the support arms can swing relative to each other without binding.

With reference to FIGURES 4 and 5, each of the support arms 18, 20 is coupled to the frame 16 of the chair in a manner allowing adjustment of the effective length of the arm. As used herein, "effective length" is the distance from the frame to the trunnioned end of the arm. As seen in FIGURES 4 and 5, the chair frame includes peripheral structural members 68, which can be tubular and of essentially square cross section. For each arm, a tunnel bracket 70 is rigidly affixed to the frame. Such bracket has an inner upright plate 72 secured to the frame and an outer upright plate 74 spaced from the inner plate 72. Plates 72 and 74 define a passage 76 through which the support arm can slide for adjustment of its effective length. More specifically, the base end portion 78 of each arm (i.e., the bottom end portion for an arm 20 and the rear end portion for an arm 18) has longitudinally spaced holes 80. A retractable locking pin 82 can be fitted in a selected hole 80 to fix the effective length of the arm. Changing the effective length of the arm inherently changes its angle relative to the frame. Consequently, the passage 76 through the bracket 70 is shaped to accommodate some limited swinging motion of the arm relative to the bracket.

The construction of the locking pin and associated structure is best seen in FIGURE 5. The locking mechanism includes a hollow body 84 rigidly secured to the frame 16, such as by welding. Body 84 has an internally threaded through passage for an externally threaded sleeve 86. The outer end of sleeve 86 moves in an unthreaded hole 88 through the inner plate 72 of bracket 70. The opposite end of sleeve 86 projects from body 84 and has an enlarged head 90 which preferably is knurled for allowing it to be turned manually. Turning head 90 in a "tightening" direction has the effect of projecting sleeve 86 outward, through the passage 88, whereas turning head 90 in the opposite direction has the effect of retracting the sleeve.

Lock pin 82 extends through an axial bore of the threaded sleeve 86. One end of the pin is secured in a knob 92. Locking pin 82 is biased to the outward projected position shown in FIGURE 5 by a helical spring mounted internally of the threaded sleeve 86, but can be retracted by pulling knob 92.

To adjust the effective length of any of the arms 18, 20, the knurled head 90 of the associated locking sleeve 86 is turned in a direction to retract the sleeve 86. Knob 92 is pulled inward to retract the lock pin 82 from whichever of the adjustment holes 80 it was captured in. The arm then can be slid lengthwise relative to bracket 70 to a position where the desired hole 80 is approximately registered with

the lock pin. Knob 92 is released to project the pin through the selected hole. Finally, the structure can be tightened and rigidified by turning the knurled head 90 in a direction to project the threaded sleeve outward. Preferably each hole 80 has internal threads complemental to the external threads of sleeve 86 for tightening the support arm in its bracket 70.

With reference to FIGURE 2, the effective lengths of support arms 18 and 20 are adjustable for a particular user of the inversion device. More specifically, the support arms are preferably adjusted such that when a user occupies the chair in the upright position shown in FIGURE 2, the combined center of gravity of the chair and the user is located at approximately the same height as the trunnions and slightly forward of them. Consequently, the chair is biased to a forward swung position. A stop is provided to limit forward swinging of the chair. In the embodiment illustrated in FIGURES 1-7, the stop is in the form of a strap 96 having one end secured to the crossbar 44 and its other end secured to the back of the chair.

With reference to FIGURES 1 and 2, the chair also includes a removable lap restraint 98 to rest over the upper thighs and lap area of the user and snugly hold the user on the seat 12. Preferably, the underside of the lap support is contoured for resting comfortably over the user and is adjustably coupled to the frame 16 of the seat. For example, the lap support can be coupled to the frame by adjustable straps similar to automotive seat belt straps. In the preferred embodiment, however, the mechanism for coupling the lap support to the frame includes a rigid bar 100 having one end portion pivotally attached to the lap support and the other end portion fitted in an infinitely adjustable latch 102, shown in greatest detail in FIGURE 6. The infinitely adjustable latch 102 includes a housing 104 through which the associated bar 100 slides. Housing 104 is pivotally secured to the seat frame, such as by a pivot bolt. The upper end of the housing has two inturned tabs 106, 108 which capture a latch plate 110. Plate 110 has a central slot 112 of a size only slightly greater than the cross-sectional size of bar 100. One of the tabs 106 is offset relative to the other tab 108, such that the latch plate 110 can swing between a position extending perpendicular to the length of bar 100 and a slightly oblique position. A spring (not shown) biases the latch plate to the oblique position. In the perpendicular position, latch plate 100 rests flush against top edges of opposite sidewalls 114 of the housing. The plate is moved toward the perpendicular position by sliding bar 100 downward through the latch plate slot 112, which results in tightening the lap support over the user. Upward sliding of the bar 100 in the slot results in canting the latch plate which binds against opposite edges of the bar to prevent it from sliding outward. Thus, the

lap support can be reliably retained in a snug position on the user. The lap support can be conveniently removed by pressing the latch plates 110 down, releasing them from their binding positions. The plates can be held in the perpendicular unlocked positions for separation of the latch bars from the housings.

Returning to FIGURE 2, the swinging chair 10 can include a leg support 118 cantilevered downward from the seat frame 60. The bottom end of the support can include horizontally spaced padded rollers 120 for engaging the user's ankles at the front and back which stably positions the legs of the user relative to the chair. As can be seen in FIGURE 2, however, the upper torso of the user is not restrained relative to the back of the chair. For example, the user shown in FIGURE 2 is slouched forward slightly, in a position to assure that the center of gravity of the user and chair is positioned forward of the swinging axis (i.e., the axis of the trunnions 26).

With reference to FIGURES 7 and 8, since the position of the chair 10 relative to the swinging axis is adjustable for different users so as to locate the center of gravity in the desired position close to but slightly forward of the axis, the user can easily alter the rotated position of the chair relative to the stand by simply changing the position of his or her upper torso and/or arms. Leaning back and/or moving the arms upward and back has the effect of shifting the center of gravity of the user and chair to a position rearward of the trunnion axis. Consequently, the chair 10 begins to rotate rearward from the solid line position shown in FIGURE 7 to the broken line position. So long as the repositioned center of gravity is located to the right of the trunnion axis as viewed in FIGURE 7, the chair will continue to rotate rearward (i.e., clockwise).

With reference to FIGURE 8, as the inverted position is reached, the body naturally hangs substantially vertically downward with the user's back spaced from the chair back 14. In the inverted position, the result is an additional shifting of the center of gravity to the right, in this case away from the chair back, such that the chair continues to be biased for clockwise direction. Strap 96 limits the maximum rotation of the chair such that the chair is maintained stably in the inverted position so long as the center of gravity is located outward (to the right) of the swinging axis.

When the user wants to return to the upright position, he or she need only swing rearward, toward the back of the chair, sufficiently that the center of gravity moves to a position inward (to the left) of the swinging axis. The chair acts like a pendulum in swinging counterclockwise toward the upright position, and continues this movement so long as the center of gravity is shifted to the left by the user changing his or her body position.

In some instances, particularly if the lap support is not tight enough, there also is a downward shifting of the body with a consequent downward shifting of the center of gravity when the inverted position is reached. In these cases, it may be difficult for the user to right him or herself by simply changing body position. As seen in FIGURE 1, preferably the stand includes handholds 116 secured to the upper brackets 28 for grasping by the user if additional force is required to begin or continue rotation of the chair toward the upright position (the handholds are deleted from FIGURES 2, 7 and 8 to prevent obscuring the trunnion area of the chair).

It is important that the position of the chair be adjustable relative to the trunnions so that the inversion device is usable by people of different statures. The position of the chair should be conveniently adjustable in a direction having a component parallel to the seat and a component perpendicular to the seat. This is permitted by supporting the seat with the adjustable bars that extend, respectively, parallel and generally perpendicular to the seat. For example, tests conducted with people of different statures have shown that for a swinging chair assembly weighing about 75 pounds, it may be necessary to shift the chair horizontally, parallel to the seat, several inches, and/or shift the chair vertically, generally perpendicular to the seat, several inches, in order to achieve the desired balancing of the chair when it is in its upright position. Even people of the same sex, height, and weight can differ with respect to the proportion of their weight carried in the upper torso. Thus, for one user adjustment of only one set of arms may be required as compared to the ideal positioning of the arms for another user, but both adjustments are required to accommodate the greatest number of users. Once the preferred positioning has been determined for a specific user, the chair can be adjusted to that position quickly and easily prior to the user sitting in the chair.

When not in use, the chair can be easily separated from the stand for storage by simply lifting it to separate the trunnions from the mounting brackets. The stand can be swung to a compact position by collapsing the side braces 40. Further, preferably the legs 32 and 34 have telescoping upper and lower sections with adjustment mechanism allowing them to be shortened. As an alternative to separating the chair from the stand and collapsing the stand, the legs can be shortened and the strap 96 adjusted such that the chair can be lowered to a normal sitting height, such that the chair can be used for normal, stable upright support of a user, like any other chair. Alternatively, the strap (or other suitable stop mechanism) can be adjusted to permit limited rotation of the chair, such as through an angle of approximately 135°.

Elevation of the chair by extending the legs is required to provide room for complete inversion.

For the embodiment shown in FIGURES 1-8, the adjustments of the effective lengths of the arms 18 and 20 are made prior to the user sitting in the chair. FIGURES 9-12 illustrate diagrammatically a power-driven embodiment in which the adjustments can be made after the user sits in the chair. In addition, while the user can adjust his or her body position to augment rotation of the chair, the power-driven apparatus can be used to effect rotation of the chair between upright and inverted positions without the user changing his or her body position.

The embodiment of FIGURES 9-12 uses a chair 10' including a seat 12' fixed relative to a back 14'. A normally horizontal support arm 18' and a normally upright support arm 20' are coupled to the chair and extend, respectively, forward and upward to a trunnion 26' of the same general type as trunnion 26 previously described. Similarly, trunnions 26' are journaled in brackets of a stand identical to the stand 30 described with reference to FIGURES 1-8. Also, the user is secured in the chair by a lap support of the type previously described.

In the case of the embodiment of FIGURES 9-12, however, the horizontal support arms 18' are coupled to the chair by power drive mechanism 130, and vertical support arms 20' are coupled to the chair by power drive mechanism 132. The power drive mechanisms 130 and 132 include actuators that cooperate with the support arms for adjusting the effective lengths of the arms. Any suitable power drive mechanism can be used including, for example, rack and pinions, screw drives, worm drives, hydraulic or pneumatic cylinders, gear drives, etc., which can be operated to shift the support arms relative to the chair. Shifting the support arms results in shifting the chair relative to the trunnions. By manipulating the center of gravity of the user and chair relative to the trunnion axis, the chair can be made to rotate as desired.

More specifically, initially arms 18' and 20' are adjusted such that the center of gravity of the swingable unit (chair and occupant) is located slightly forward and below the trunnion axis for users of different statures, i.e., at approximately position 134 shown in FIGURE 9. In this position, the chair is biased to a forward swung position against a stop 136. It should be understood that stop 136 is shown diagrammatically and can consist of any suitable structure preventing forward tilting of the chair from the solid line position shown in FIGURE 9. For example, a strap connected between the stand and the chair can be used, similar to strap 96 described with reference to the embodiment of FIGURES 1-8.

To begin the rearward swinging of the chair (clockwise as viewed in FIGURE 9), first the effective length of the horizontal arm 18' is increased by use of the power drive mechanism 130. As represented in broken lines in FIGURE 9, this results in shifting the chair rearward, to the right as viewed in FIGURE 9. The center of gravity 134 shifts rearward, i.e., toward the position indicated at 138. However, the chair does not actually reach the broken line position shown in FIGURE 9, because once the center of gravity has shifted to a position rearward (to the right) of the trunnion axis, the chair swings in pendulum fashion because the equilibrium position is always with the center of gravity located vertically below the trunnion axis. Thus, the chair begins a rearward (clockwise) rotation.

Thereafter, the chair continues to rotate rearward (clockwise) so long as the center of gravity continues to be shifted in the same lateral direction relative to the trunnion axis. By increasing the effective length of the support arms 18', the chair can be made to rotate at least about 45 degrees to the position shown in solid lines in FIGURE 10. In such position, both support arms 18' and 20' are inclined upward and inward to the axis of trunnions 26'. At this time, additional rearward (clockwise) rotation of the chair can be induced by continuing to shift the center of gravity of the swinging unit to the right, which can be achieved by continuing to increase the effective length of the back-coupled arm 18', or by decreasing the effective length of the seat-coupled arm 20', or a combination of such actions. Increasing the effective length of arm 18' drives the seat back down and to the right, whereas decreasing the effective length of arm 20' lifts the chair seat up and to the right. In either case the chair must swing clockwise toward the equilibrium position in which the center of gravity is located vertically below the trunnion axis.

For example, as described above, rotation of the chair from the solid line position shown in FIGURE 9 to the solid line position shown in FIGURE 10 can be induced solely by increasing the effective length of arm 18'. The center of gravity will be vertically below the axis of trunnions 26', at approximately position 140. Continued lengthening of support arm 18' tends to translate the center of gravity toward position 142 which causes the chair to continue the rearward (clockwise) rotation. Shortening support arm 20' tends to translate the center of gravity toward position 144 which also has the tendency of inducing the chair to continue the rearward (clockwise) rotation.

At some point, arm 18' will be at its maximum effective length, and continued rotation of the chair can be induced solely by decreasing the effective length of arm 20'. Also, depending upon the geometry, a position can be reached at which

arm 18' is at its maximum effective length, and arm 20' is at its minimum effective length, represented in solid lines in FIGURE 11. The chair is nearly inverted, and the center of gravity at position 146 is vertically below the axis of trunnions 26'. The chair has been rotated through a sufficient angle that arm 18' has swung past a vertical position. Consequently, continued rearward (clockwise) rotation of the chair can be induced by *shortening* arm 18', which has the tendency of translating the center of gravity from position 146 toward position 148, to the right of the trunnion axis. The chair will continue to rotate clockwise.

The adjustment of the effective lengths of the support arms can be discontinued and the chair will assume an equilibrium position with the center of gravity vertically below the trunnion axis. Nevertheless, with reference to FIGURE 12, it is preferred that a stop 149 be provided to limit the rearward rotation of the chair and establish a stable inverted position, such as when the body of the user hangs in approximately the position shown in FIGURE 8 with his or her back spaced from the back of the chair. Stop 150 is shown only diagrammatically and any suitable stop mechanism can be used, including a strap similar to strap 96 described with reference to the embodiment of FIGURES 1-8.

With reference to FIGURE 9, the power drive mechanism or actuators 130 and 132 can be controlled separately. An alternative is to provide a control system 151 (shown diagrammatically) using limit switches or other position sensors.

The principles of operation of the power-driven embodiment of the present invention were confirmed by construction and operation of a prototype shown in FIGURES 13-17. With reference to FIGURE 13, the prototype uses a stand 30' (deleted in FIGURES 14-17) of the general type previously described, including front legs 32 inclined downward and forward from upper brackets 28 and rear legs 34 inclined downward and rearward from the brackets. Trunnions 26" are journaled in the brackets, and pivotally connect the front ends of support arms 18" to the upper ends of vertical support arms 20". Such support arms were coupled to the frame by a power-driven mechanical crank and linkage assembly to allow adjustment of the effective lengths of the arms.

Some components of the mechanical crank and linkage structure were rigidly connected to the frame 16' of the chair 10". Such rigidly connected components (i.e., components fixed stationary relative to the chair frame) include a diagonal bar 150 at each side of the chair. Each bar 150 is inclined from a lower front end 152 to an upper rear end 154. The lower front end portions of the diagonal bars 150 are connected by a cross bar 156 that extends below the chair seat. Another stationary

cross bar 158 extends below the chair at approximately the junction of the seat and back, and has its opposite ends rigidly connected to the diagonal bars 150 by angle plates 160.

The other components of the mechanical crank and linkage assembly are movable relative to the diagonal bars 150 and their cross bars 156 and 158. First, toward the rear of the chair, corresponding bell cranks 162 have their central portions 164 pivoted to the rear upper ends 154 of diagonal bars 150. Each bell crank includes a top leg 166 inclined upward and rearward to its point of pivotal connection to the rear end of the corresponding support arm 18", and a lower leg 168 inclined downward and rearward to a cross bar 170 that connects the bottom end portions of the lower legs 168. Mechanism was provided for adjusting the distance between cross bar 158 which is stationary relative to the chair and cross bar 170 which adjusts the positions of the belt cranks 162 and, consequently, the effective lengths of support arms 18". In the prototype, a power driven jackscrew and nut actuator 172 was salvaged from the power seat of an automobile. Driving the screw so as to increase the distance between the stationary cross bar 158 and the bell crank bottom cross bar 170 has the effect of swinging the upper cross bar legs 166 forward which increases the effective length of support arms 18".

For adjustment of the effective length of the vertical support arms 20", the bottom ends of such arms are pivotally joined to horizontal links 180 having leading end portions connected by a cross bar 182 extending beneath the chair. The trailing ends of links 180 are pivotally connected to the angle plates 160. A jackscrew and nut drive 184, salvaged from an automobile power seat, is effective to adjust the distance between the stationary cross bar 156 and the adjacent cross bar 182. Because of the geometry, increasing the distance between cross bars 156 and 182 has the effect of decreasing the effective lengths of the vertical support arms 20".

FIGURES 14-17 illustrate sequential stages in inversion of the chair 10". In the starting position shown in FIGURE 14, both jackscrew drives are fully "retracted" such that cross bars 158 and 170 are close together and cross bars 156 and 182 are close together. To effect inversion, first jackscrew 172 is driven which moves cross bars 158 and 170 apart, and increases the effective length of the upper support arm 18". Since the trunnions 26" are necessarily at a fixed location by virtue of their connection to the stand, the chair 10" is shifted rearward which shifts the center of gravity to a position behind the pinion axis, and the chair rotates rearward (clockwise). FIGURE 15 shows the equilibrium position of the chair as the maximum effective length of the upper support arm 18" is approached.

Next, jackscrew 184 is driven to increase the distance between the stationary cross bar 156 and cross bar 182 coupled to the support arms 20". Because of the geometry, the result is a decrease in the effective length of the support arms 20". The chair seat is raised relative to the trunnion axis, and the center of gravity is again shifted to the right, causing the chair to continue its rearward (clockwise) rotation. FIGURE 16 shows the attitude of the chair as maximum extension of jackscrew 184 is reached.

From the position shown in FIGURE 16, additional rotation of the chair can be induced by now shortening the effective length of the support arms 18", now that they have moved past the vertical position. This can be done by driving jackscrew 172 in a direction to lessen the distance between bars 158 and 170. FIGURE 17 illustrates the resultant fully inverted position.

While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An inversion device comprising a chair, a stand, and means mounting the chair on the stand for swinging of the chair about a generally horizontal axis extending transversely of the chair between an upright position and an inverted position, said mounting means allowing adjustment of the position of the chair relative to the axis to shift the center of gravity of the chair (and any user therein) relative to the axis in a direction other than concentric about the axis.

2. The device defined in Claim 1, in which the mounting means allows shifting of the chair relative to the axis in a direction having a component generally parallel to a back of the chair and a component generally parallel to a seat of the chair.

3. The device defined in Claim 1, in which the mounting means includes at least one support arm coupled between the chair and the stand adjacent to the axis of rotation, said support arm being of adjustable effective length.

4. The device defined in Claim 1, in which the chair includes a seat and a back, the mounting means including a first support arm extending generally parallel to the seat, a second support arm extending generally parallel to the back, said support arms having corresponding end portions pivotally connected to the stand, said support arms being of adjustable effective lengths.

5. The chair defined in Claim 4, in which the mounting means includes means for coupling the support arms to the chair and allowing manual adjustment of the effective lengths of the support arms.

6. The chair defined in Claim 5, in which the coupling means includes a retractable locking pin.

7. The device defined in Claim 4, in which the mounting means includes power drive means for adjusting the effective lengths of the arms.

8. The method of inverting a chair which comprises mounting the chair in a stand for swinging about a generally horizontal axis extending transversely of the chair, and shifting the center of gravity of the chair (and any occupant therein)

laterally relative to the center of gravity in a manner and to an extent to effect rotation of the chair from an upright position to an inverted position.

9. The method defined in Claim 8, including shifting the center of gravity of the chair by shifting the chair relative to the axis.

10. The method defined in Claim 9, in which the chair is mounted in a stand by support arms coupled between the chair and the stand, and including shifting the center of gravity of the chair by changing the effective lengths of the support arms.

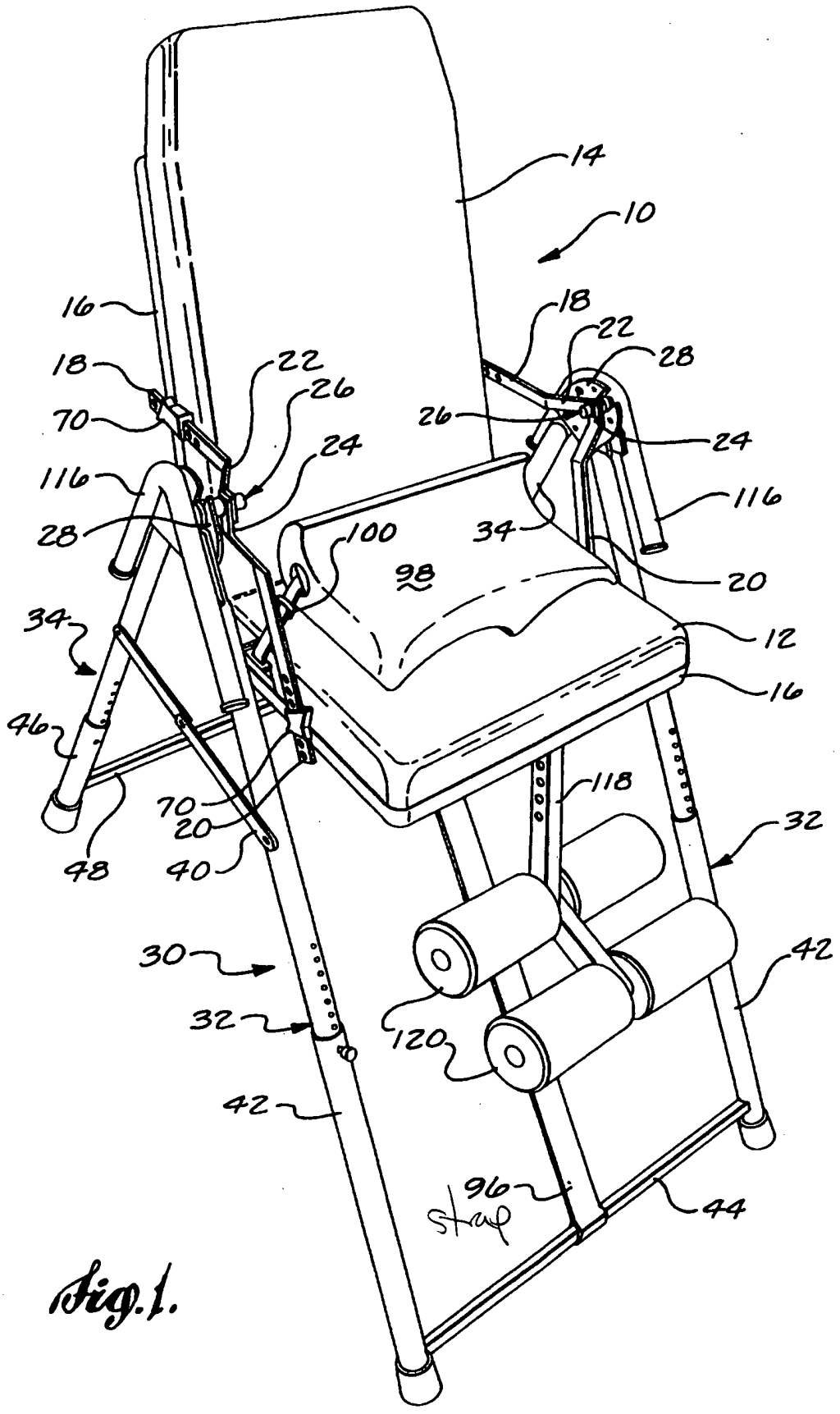
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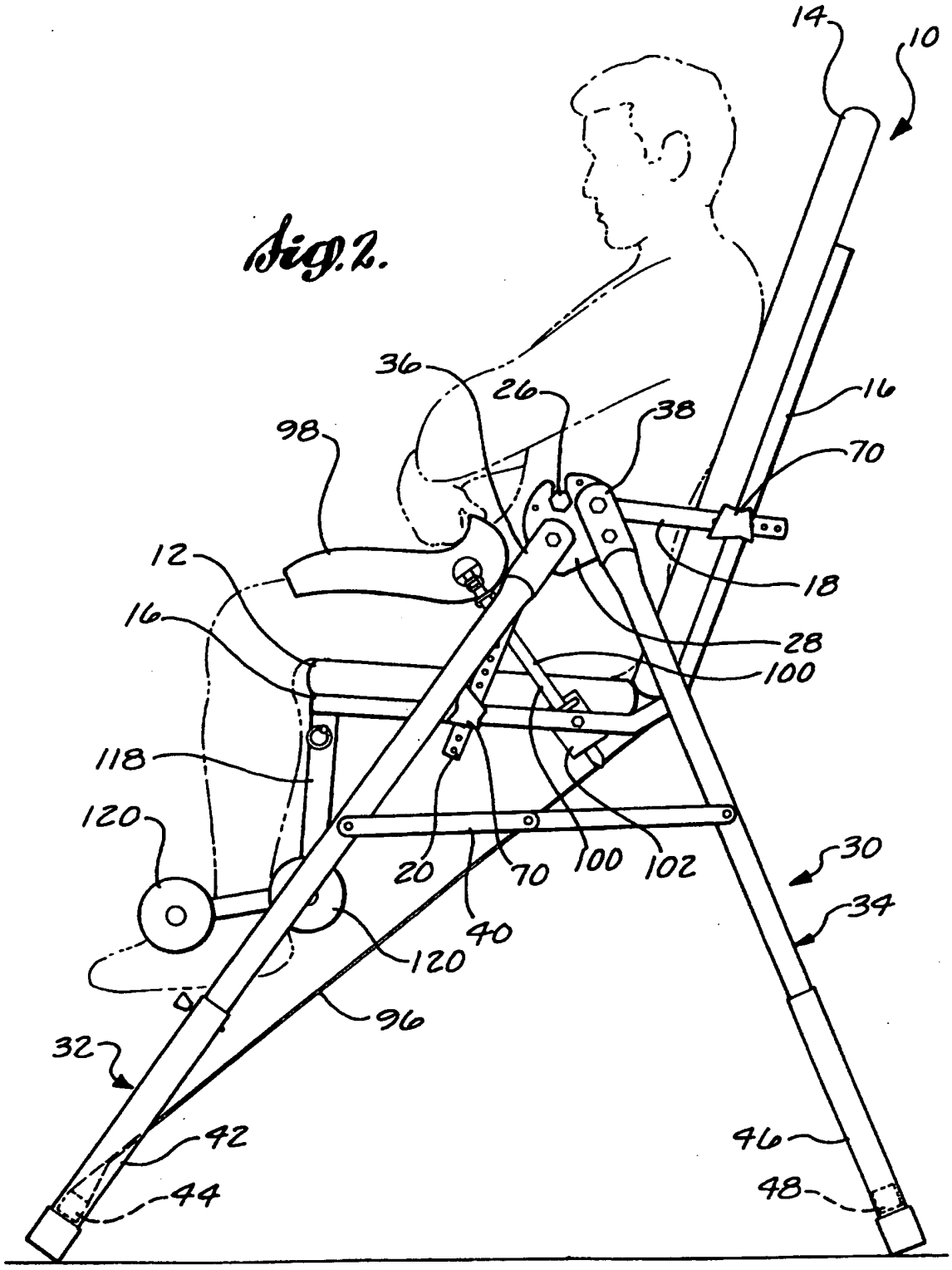
Fig. 1.

Fig. 2.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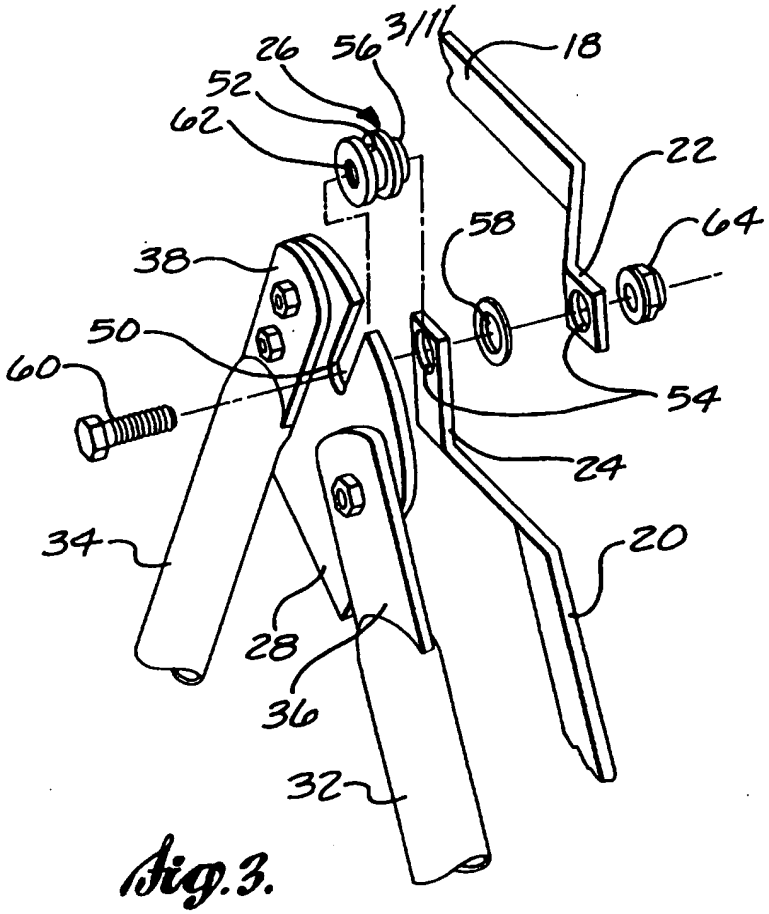
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Fig. 3.

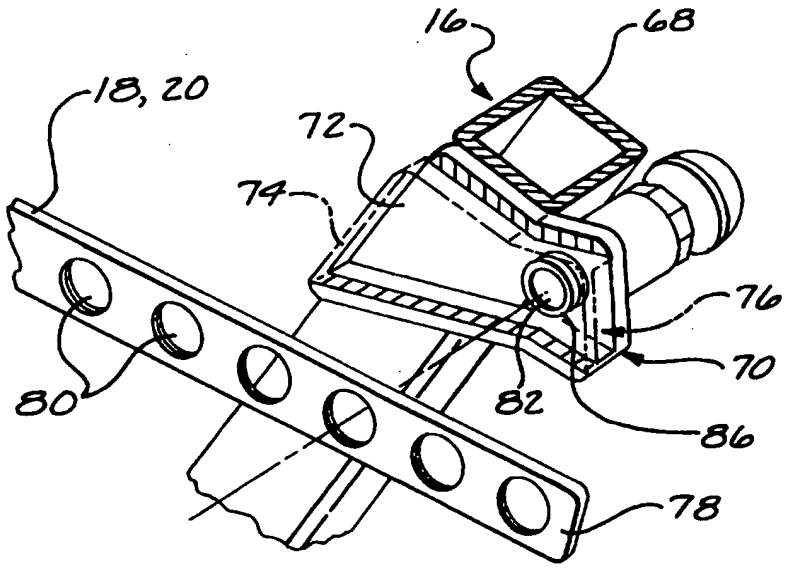
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Fig. 4.

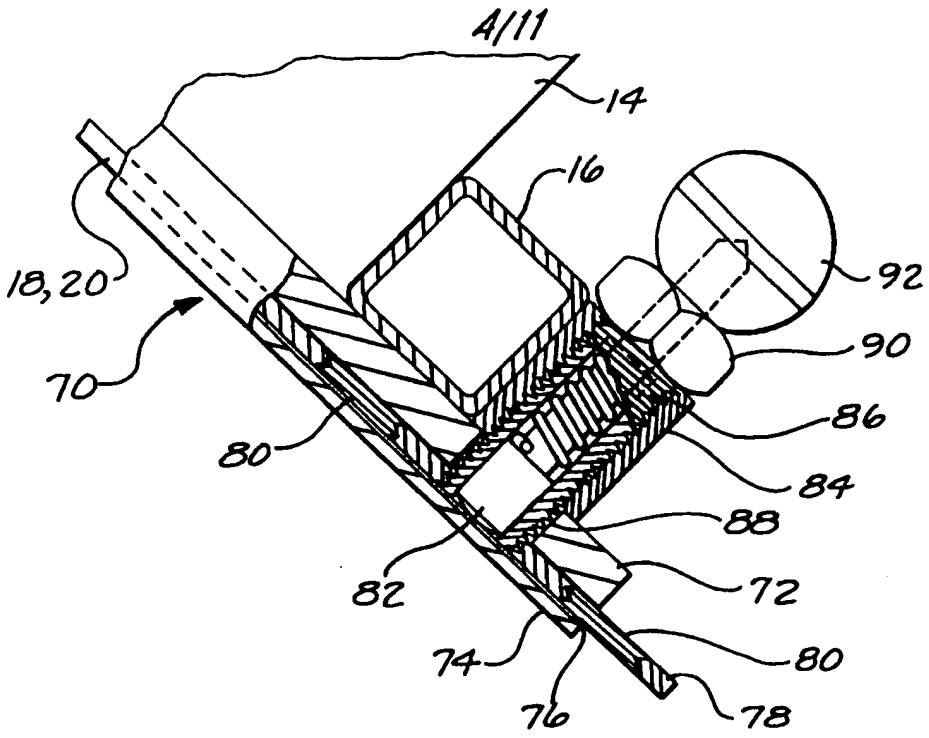
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Fig. 5.

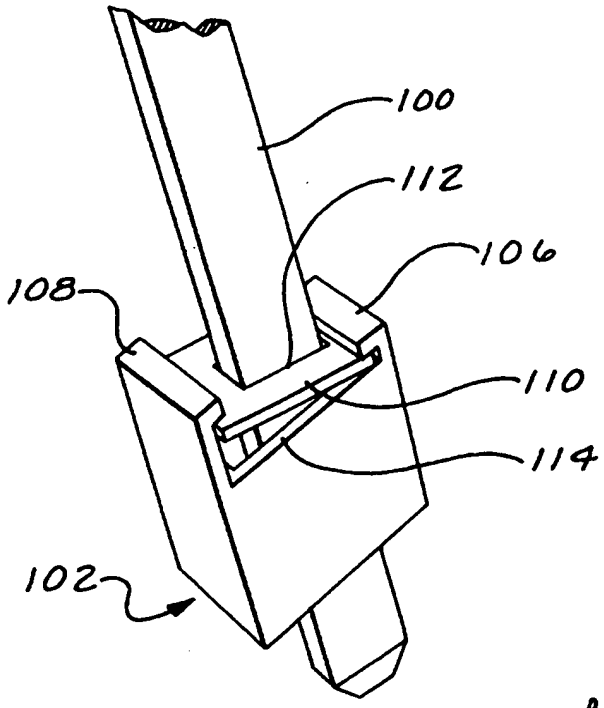
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Fig. 6.

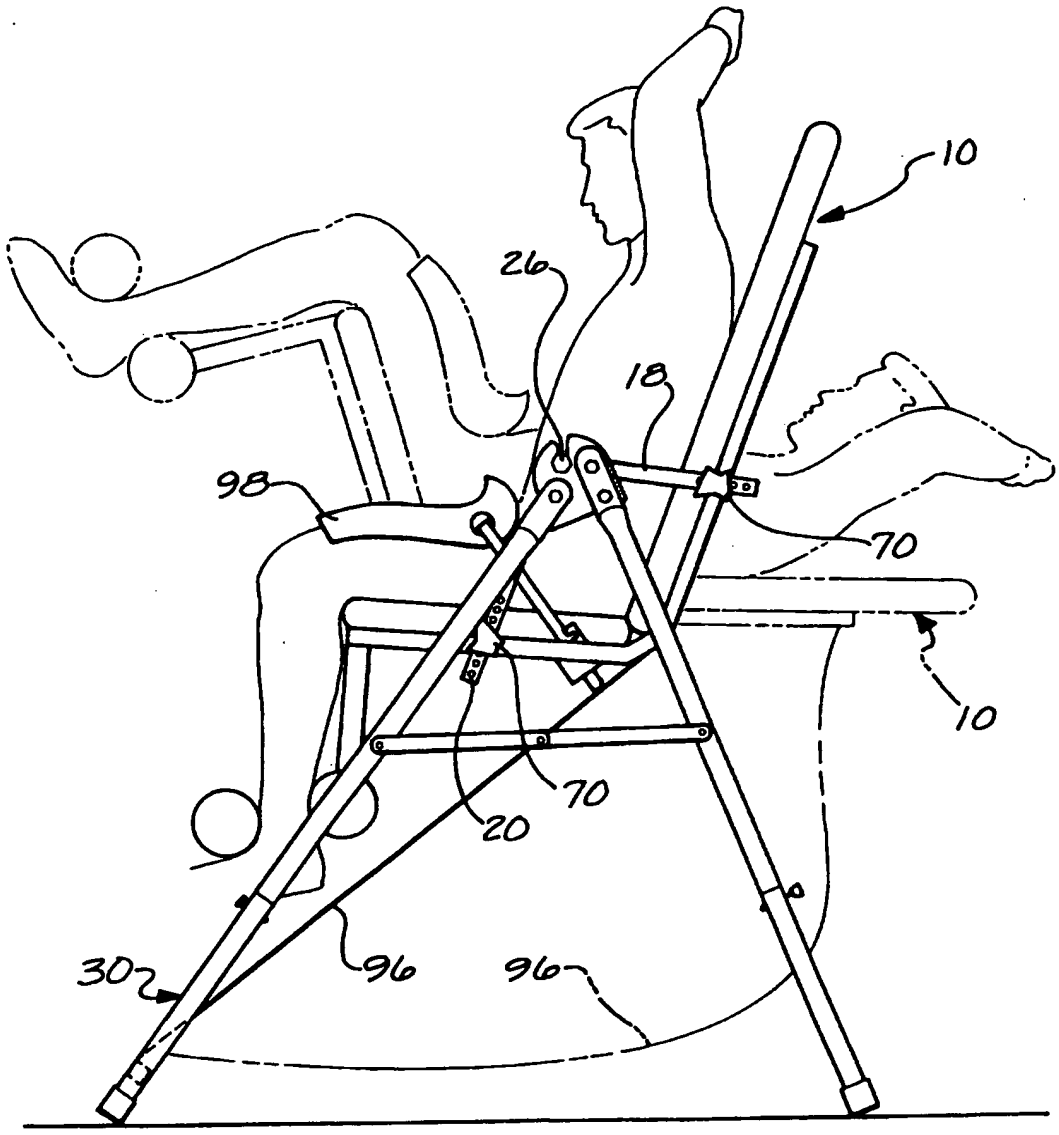
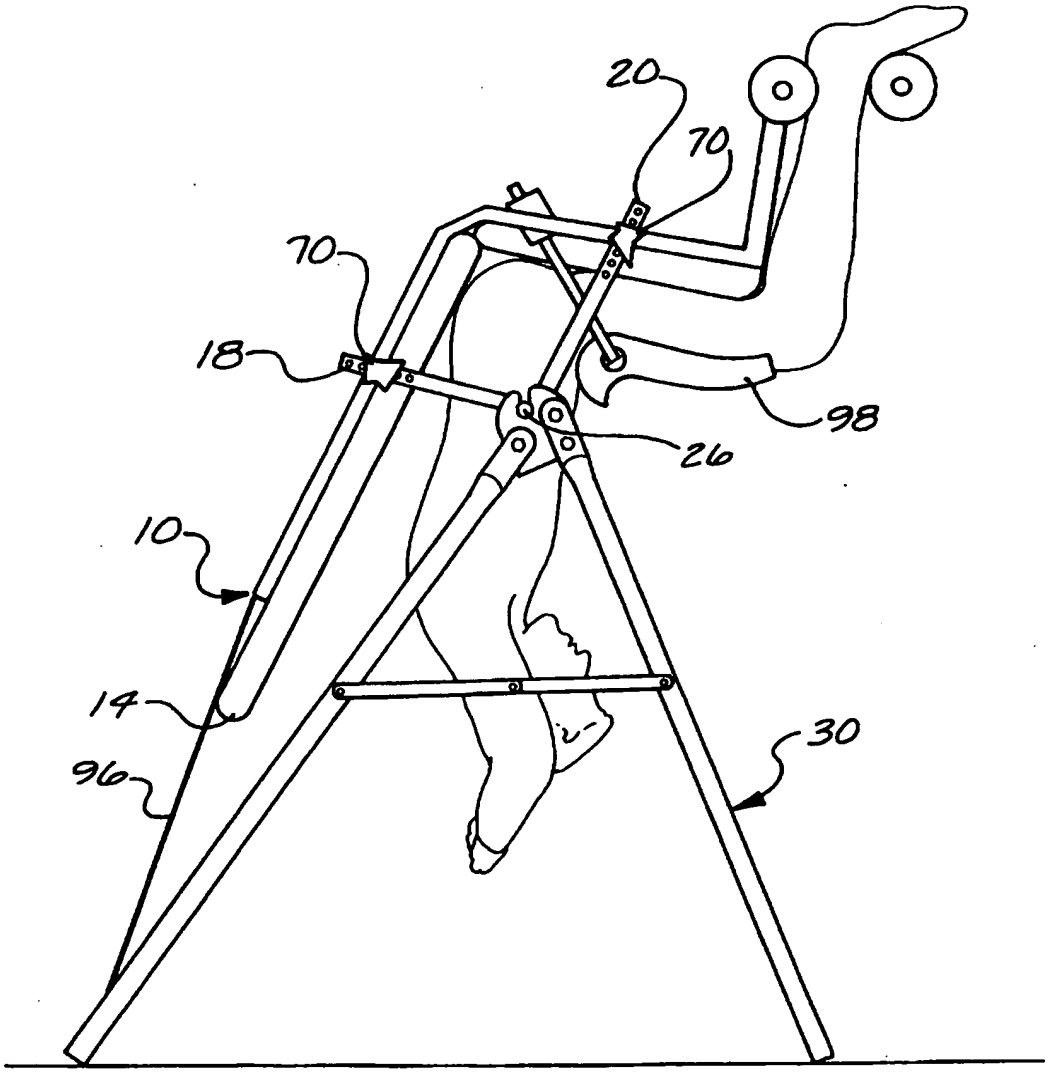


Fig. 1.



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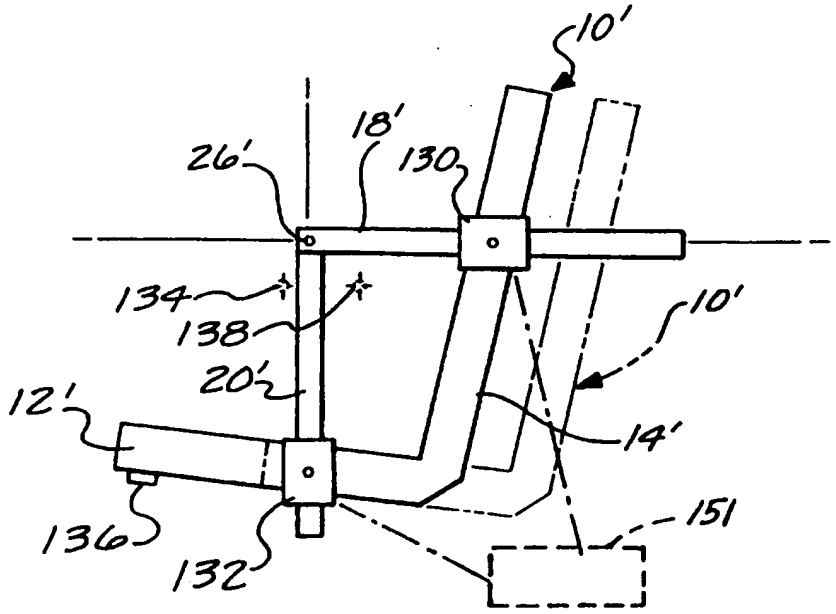
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134
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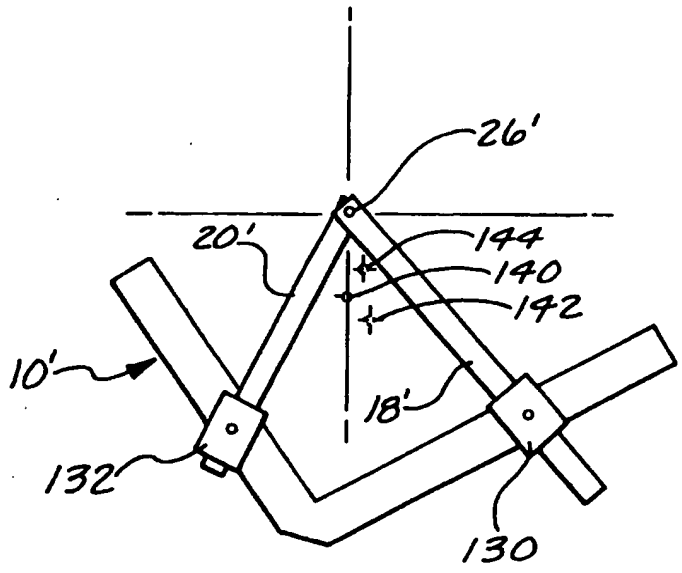
20'
12'
14'
136
132
151

Fig. 9.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18'
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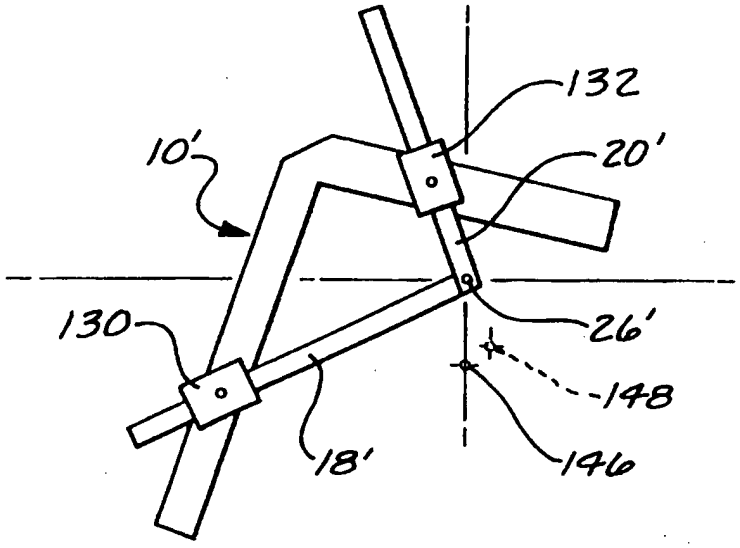
Fig. 10.



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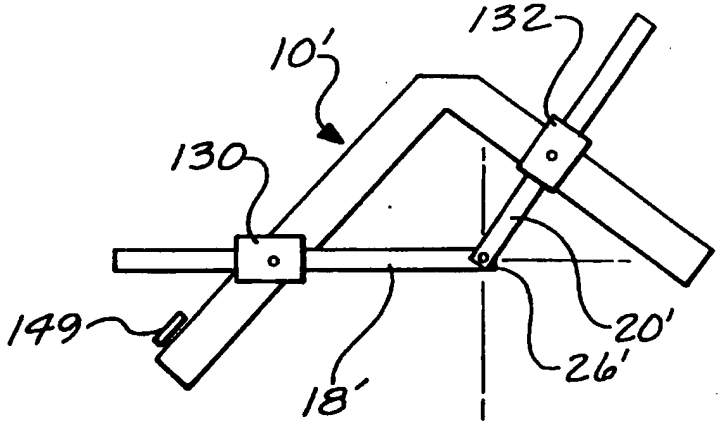

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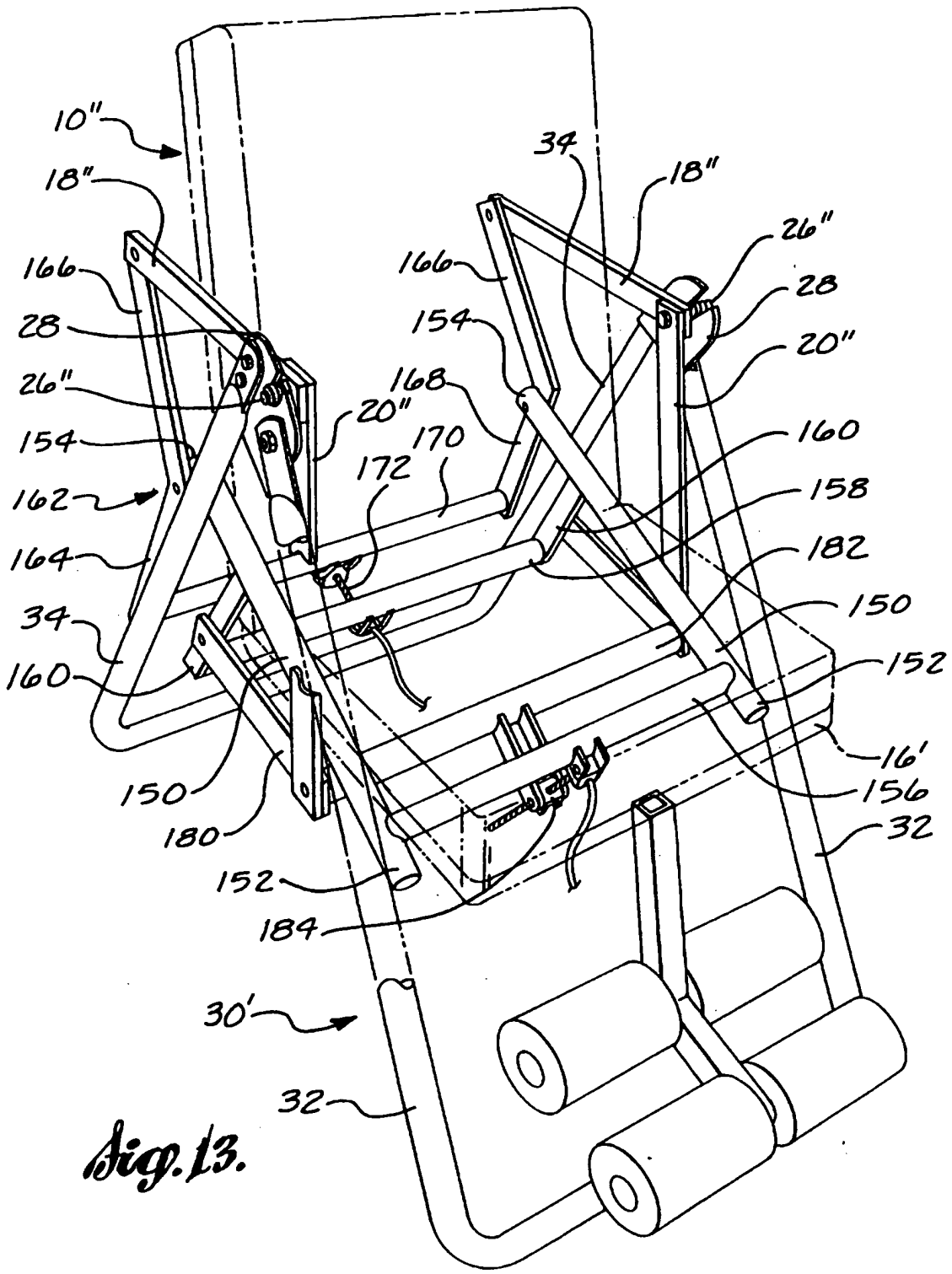
10"
18"
166
28
26"
154
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184
30'
32
34
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26"
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154
20"
168
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158
182
150
152
16'
156
32
20"
170
172

Fig. 13.

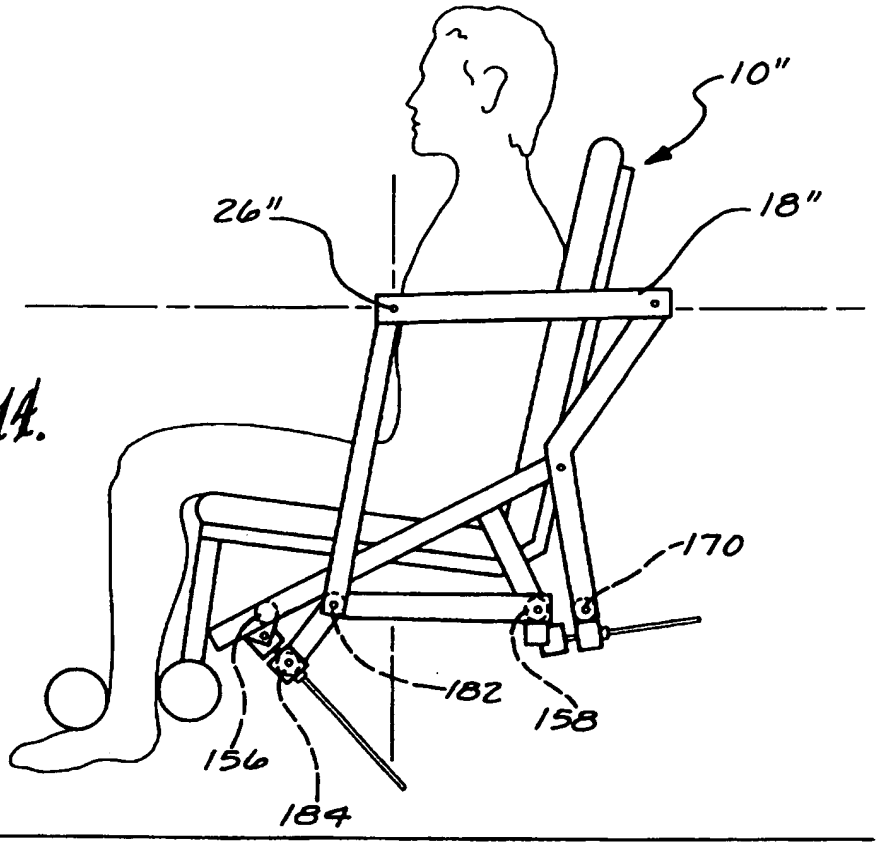

Fig. 14.

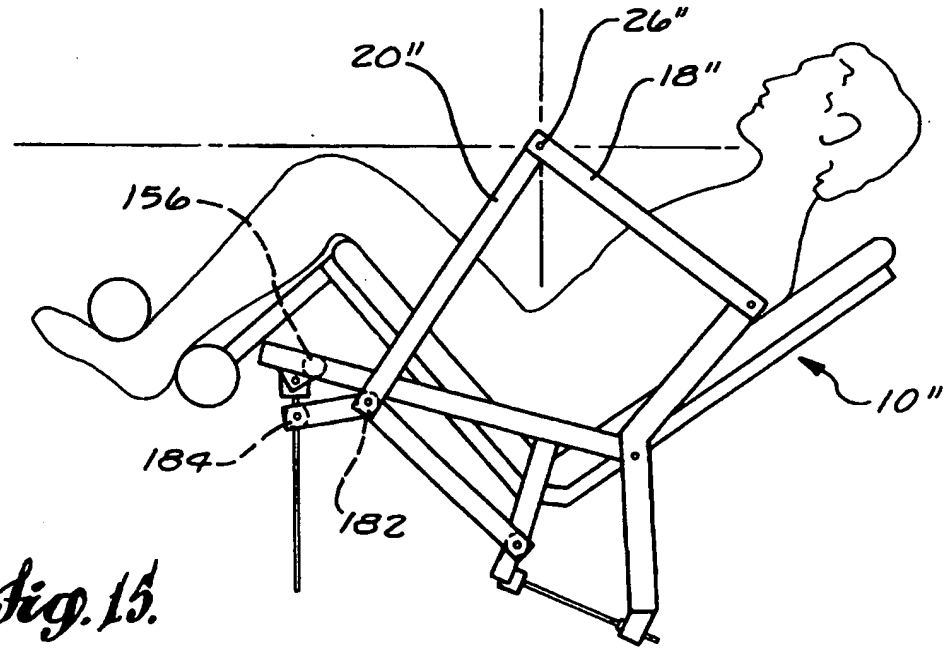

Fig. 15.

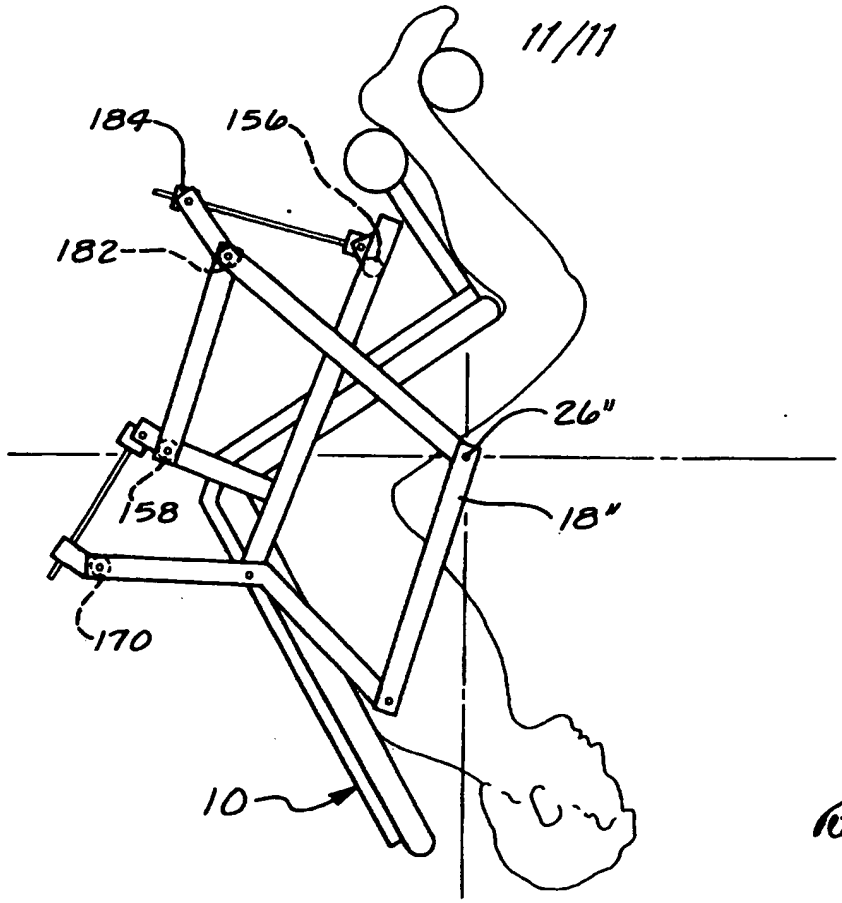

Fig. 16.

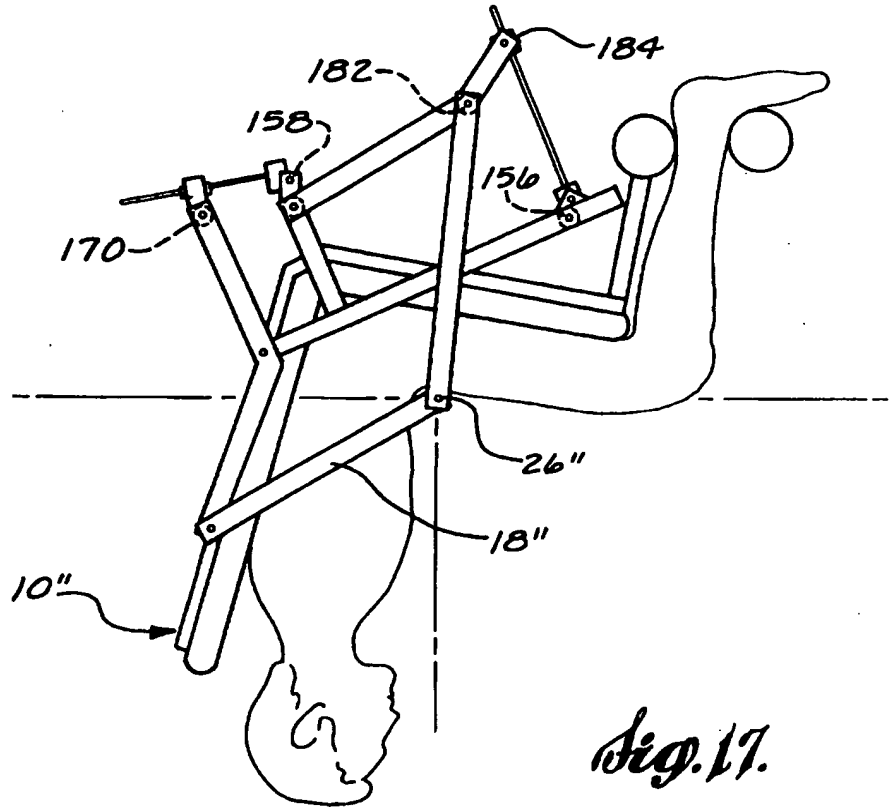

Fig. 17.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/01569

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A63B 26/00
US CL :482/143, 144

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 482/143,144

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,031,905 (WALSH) 16 July 1991, see entire document.	1-10
Y	US, A, 4,546,972 (GOYER) 15 October 1985, see entire document.	1-10
Y	US, A, 4,214,790 (SIEBER) 29 July 1980, see entire document.	1-10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 19 JUNE 1996	Date of mailing of the international search report 17 JUL 1996
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer LYNNE A. REICHARD Telephone No. (703) 308-1159

Form PCT/ISA/210 (second sheet)(July 1992)*